Salaita et. al., Nature Nanotechnology 2016). Ribonuclease H enables translocation by cleaving the RNA-DNA duplexes, resulting in an RNA depletion track in the HPDM's wake. Translocating for hours at micron/minute speeds, HPDMs are the fastest, most processive DNA-based motors reported to date. To test HPDMs' force generation capability we designed a single molecule fluorescence microscopy experiment which enables direct visualization of mechanically-ruptured molecular bonds. Surprisingly, we found that HPDMs generate forces that mechanically rupture 25 basepair DNA duplexes and biotin-streptavidin bonds (the strongest noncovalent bonds found in nature with 100+ pN force thresholds). HPDMs lack directed tracks and conformational switching such as ATP-fueled powerstrokes, thus underscoring the novelty of this result. To study this fundamental mechanism of force-generation, we developed a simulation method that accurately reproduces most properties of HPDM motion via direct modeling of the distance-dependant biophysics of DNA-RNA interactions. These simulations highlight the mechanism of HPDM force generation and demonstrate that motion is driven by autochemophoresis, which has been observed in biological systems (Sugawara & Kaneko, Biophysics 2011). Our work suggests that autochemophoresis may be a third fundamental method of force generation in molecular motors and living systems.

1443-Pos

Optically Assisted Localization of Solid-State Nanopore during Controlled Breakdown Fabrication

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A number of nanopore-based applications such as tunneling current sensing and plasmonic nanopores would require the nanopore to be specifically localized. So far, CBD-based nanopore localizing efforts often require additional lithography patterning process, thus limiting its flexibility and tunability. Optical beams can be manipulated to tightly focus into any arbitrary spot, offering an alternative approach for solid-state nanopore localization. It has been shown an enhanced electric field by pre-patterned plasmonic structure could lead to nanopore fabricated in desirable locations. In addition, high laser power was shown to directly etch (drill) the nanopore on silicon nitride (SiN_x) membranes through heat effect. While both the localized electric field enhancement and the heat effects were demonstrated for nanopore localization in previous studies, it remains unclear if a non-enhanced and non-etching optical beam could assist the nanopore localization during the controlled breakdown fabrication. To this end, we studied the nanopore formation characteristics under the influence of various beam intensities and wavelengths. We demonstrated nanopore localization within the submicron range of the optically exposed area. We anticipate the optically assisted nanopore localization could enable broader access to the solid state nanopore-based sensing applications.

1444-Pos

Nanofluidic Chips for DNA and Nanoparticles Detection and Manipulation

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Fluidic transport through nanostructures allows to probe fundamental phenomena at nanoscale and develop tools for DNA and nanoparticles' (NPs) sensing and manipulation. Moreover, it allows to handle small sample quantities for fast, high-resolution and low-cost analysis [Huh et al *Nature Materials,* 2007].

Here, we used different planar elastomeric nanofluidic devices, fabricated first using Focused Ion Beam (FIB) milling technique and then a Poly(DiMethylSiloxane) (PDMS) based REplica Molding (REM) process [Fanzio et al *Lab on chip*, 2011], that allows to control the geometry of nanostructures. In particular, we have optimized this manufacturing process using hard-PDMS (h-PDMS) that, having a higher Young's modulus, allows to avoid the structural collapse of nanostructures, during the sealing process with a coverslip, which typically occurs when standard PDMS is used because of surface interactions between replica and glass. We have used these versatile devices both for counting and sizing NPs and biomolecules, and for studying DNA stretching dynamics.

On one side, combining the optimized fabrication process with Resistive Pulse Sensing (RPS) technique [Angeli et al *Nano Letters*, 2015], we have analyzed translocation processes and the NPs/DNA motion inside the nanochannel as transient variation in ionic current during translocation events, allowing a label-free sensing that is a crucial application for many fields such as medicine, environment and public health. While, on the other side we have studied DNA stretching dynamics into nanostructures provided of several cavities. We observed how DNA stretches and recoil, due to the balance between entropic and excluded volume interactions, under constant voltage bias. So, we investigated the conformational variations of this polymer evaluating the dwell time in such nanocavities and the DNA speed when passing from one cavity to another one. These studies are important for advances in DNA barcoding technology.

1445-Pos

Biomimetic, Voltage-Sensitive Nanopores with Local Control over Pore Position, Size and Surface Chemistry

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Excitable ion channels play an essential role in biology by regulating ion transport across cell membranes. A key characteristic of these nanoscale pores is the ability to respond to environmental stimuli such as changes in the local membrane voltage or ion concentration. The replication of this behavior in synthetic nanopore platforms has the potential to enable new responsive materials useful in applications such as biomimetic componentry, drug delivery and filtration technologies. While voltage gating has been demonstrated before in synthetic nanopores, previous fabrication methods make it difficult to incorporate such pores into more complex systems due to lack of control over key attributes such as pore location. Here, we present the fabrication of a voltage and ion concentration responsive nanochannel with local control over the pore location, size, shape and surface chemistry. This is achieved using focused ion beam (FIB) to nanomachine a pore in a SiN_x membrane followed by ion-beam-controlled deposition of SiO_x around the pore entrance. Chemistry selective for SiO_x is then used to graft single stranded DNA (ssDNA) only to the regions where the local deposition was performed. Recorded voltage-sensitive transport is complex and dictated by both the charge and conformational changes of ssDNA chains in confinement. For small enough pore diameters, interplay between the applied voltage and local ion concentrations at the pore opening results in three pore states, each with different conductance behavior. Hysteresis was also observed, which is attributed to steric barriers to ssDNA conformational changes in a confined space. This successful demonstration of biomimetic nanopores with local control of multiple chemical and geometric properties is an important step towards the integration of nanopore technology into more complex multi-component systems.

1446-Pos

A Robust Mechanism to Render Artificial Nanopores Potassium Ion Selective

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Biological channels in a cell membrane have inspired scientists to create biomimetic nanopores for biosensing, separation, and design of ionic circuits. One of the key properties of biological channels is the ability to transport one type of ion, for example potassium ion, but prevent the passage of other ions of the same valence, like sodium ions. This ability has been attributed to the sub-nanometer dimension of biological channels' opening combined with a pore wall chemistry tuned with atomistic precision. While crucial in many physiological processes including nerve signaling, this exquisite selectivity is very difficult to reproduce in artificial nanopore systems. We have developed a strategy to create potassium ion selective channels, which is applicable to solid-state nanopores machined in essentially any material. As proof of concept, we used a model system consisting of a single nanopore formed in a 30 nm thick silicon nitride membrane by the process of dielectric breakdown. The nanopore was subsequently subjected to chemical modification, which resulted in a monolayer of 4'-aminobenzo-18-crown-6 ether on the pore walls and on one membrane surface. The other membrane surface was decorated with ssDNA. Ion selectivity was quantified as the ratio of ionic currents measured in KCl and NaCl. Nanopores with diameters below 2 nm exhibited currents in KCl that were up to 80 times larger than currents measured in NaCl, even at a salt concentration of 1 M. Experimental data and modeling provide evidence that the potassium selectivity occurs via facilitated transport of potassium ions, which undergo binding/unbinding to crown ethers on the pore walls. Transport of Na^+ is limited by the small opening, which hinders any non-selective passage. Our fabrication strategy of ion selective pores opens new avenues toward advanced separation processes, biosensing technologies and biomimetic nanopore systems.